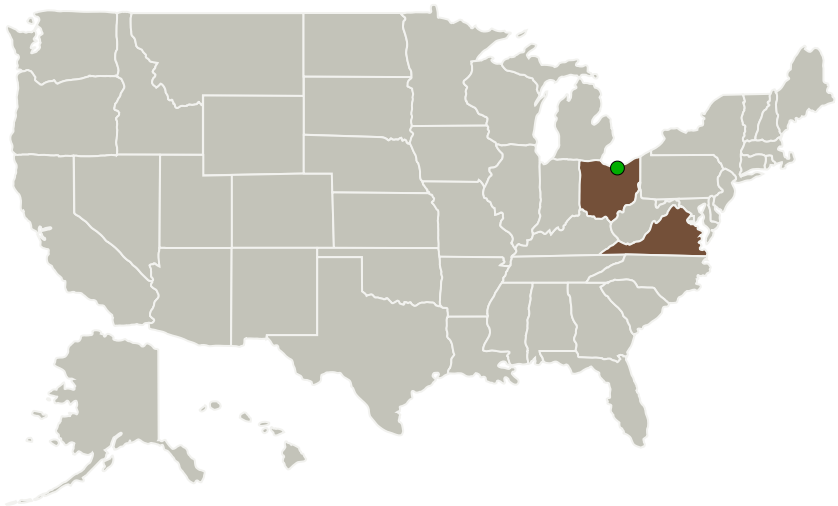
Metamaterials-Inspired Aerospace Structures (MIAS), Phase I

Completed Technology Project (2015 - 2015)

Project Introduction

The vibroacoustic characteristics of structures are vital in determining the operational envelope and mission feasibilities. The sources of vibroacoustic excitation are mainly due to noise generated by the launcher during ignition, lift-off, and atmospheric flight. Typically, foam or fiberglass claddings and cores or acoustic liners which incorporate resonating chambers are used to prevent the transmission of sound through such structural locations. However, this approach is found to be ineffective for vibroacoustic sources with dominant frequency content below 400 Hz. It is proposed to develop a metamaterial-inspired composite structure incorporating low-frequency vibro-impact resonating elements coupled with conventional high-frequency acoustic absorbers. The idea is to employ structurally-integral tuned resonators to pick up energy from incident low-frequency sound waves and utilizing the mechanism of frequency up-conversion via impacts, transfer the energy to higher modes in the sandwich primary structure for subsequent dissipation with conventional acoustic absorbers. The advantage of the proposed structure would be in reducing the transmitted pressure of low frequency waves, for which conventional methods are ineffective. Our initial bound for the attachment mass is within 5 to 10% of the baseline structure to show significant peak pressure reduction for LF waves. The state-of-the-art conventional absorbers provide about 10-20% sound transmission loss (STL) in the 100-150 Hz range. Our performance objective is to achieve STL of about 50-60% in frequency range below 400 Hz with 5-10% mass increase without deteriorating stiffness response of the structure. Successful completion of Phase I work will result in a "proof-of-concept" MIAS unit cell. In Phase II, detailed design and fabrication of the MIAS prototype panel will be completed.

Primary U.S. Work Locations and Key Partners



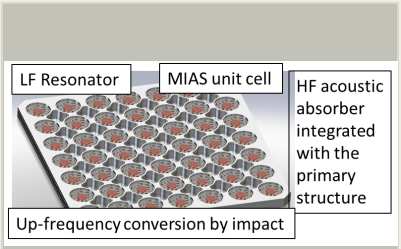


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Table of Contents

Small Business Innovation Research/Small Business Tech Transfer

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Organizations Performing Work	Role	Type	Location
Concepts to Systems, Inc.	Lead Organization	Industry Minority-Owned Business, Small Disadvantaged Business (SDB)	Danville, Virginia
Glenn Research Center(GRC)	Supporting Organization	NASA Center	Cleveland, Ohio

Primary U.S. Work Locations	
Ohio	Virginia

Project Transitions

June 2015: Project Start

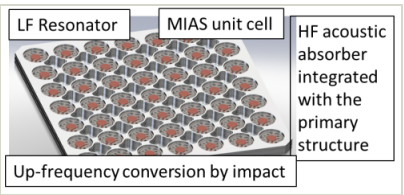
December 2015: Closed out

Closeout Summary: Metamaterials-Inspired Aerospace Structures (MIAS), Phase I Project Image

Closeout Documentation:

- Final Summary Chart Image*(https://techport.nasa.gov/file/139210)*

Images



Briefing Chart Image
Metamaterials-Inspired Aerospace Structures (MIAS), Phase I *(https://techport.nasa.gov/image/132409)*

Organizational Responsibility

Responsible Mission Directorate:
Space Technology Mission Directorate (STMD)

Lead Organization:
Concepts to Systems, Inc.

Responsible Program:
Small Business Innovation Research/Small Business Tech Transfer

Project Management

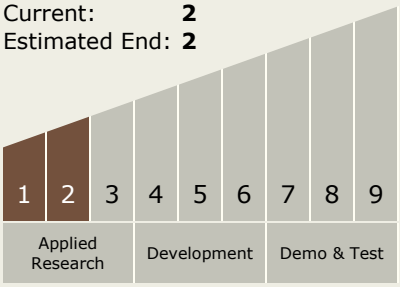
Program Director:
Jason L Kessler

Program Manager:
Carlos Torrez

Principal Investigator:
Shiv P Joshi

Technology Maturity (TRL)

Start: **1**
Current: **2**
Estimated End: **2**



Metamaterials-Inspired Aerospace Structures (MIAS), Phase I

Completed Technology Project (2015 - 2015)

Technology Areas

Primary:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
  - TX12.2 Structures
    - TX12.2.5 Innovative, Multifunctional Concepts

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System